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areas: May, 108; June, 105; July, 107; August, 115. These results are obtained approximately by the use of the skiameter. The *intensity* of the sunshine varies inversely with the areas of distribution. In the month of June, when the intensity of sunshine is greatest, the average cloudiness is 32 per cent.; in 1901 the average cloudiness was 31 per cent. Therefore, the withdrawal of the friendly cloud shelter by the amount of 1 per cent. in the month when the intensity was greatest served still further to increase the tress laid upon the plant in the year 1901.

These causes all happened to combine directly in this particular year to menace the future of the verbena. They also operated indirectly, so far as they favor other plants that know how to get along with the reduced amount of moisture and the increased amount of sunshine and heat.

The botany of the verbena, therefore, becomes chiefly a study of the various devices of leaf, stem, and root by which this plant is able to maintain itself against all these unfavorable influences, which the work in number shows to be actual and definite forces of enormous power.

GEOGRAPHY.

ZONIA BABER.

OUTLINE FOR ELEMENTARY SCHOOL.

(CONTINUED FROM NOVEMBER.)

WITH increase of knowledge, the necessity of a closer and more complete classification of facts is apparent. But, while the value of the cataloguing of information under the heads of history, literature, science, mathematics, art, etc., is admitted, its unwholesome reaction on pedagogy must also be confessed. The inseparable relation of the subjects, the interdependence of one upon the other, has been overlooked. The instructor has, for instance, tried to teach history from material within the covers of a book labeled by the historian, without recognizing the fact that appreciation of the behavior of men and nations in the past is absolutely dependent upon, and inseparable from, that knowledge which the geographer has classified under another head.

The understanding of geographic facts necessitates a knowledge of science, mathematics, and history, and demands expression in reading, writing, modeling, drawing, painting, and making.

In the course in geography outlined for the elementary school, certain phases of a subject under consideration may properly belong to history, science, mathematics, or art; but whatever has seemed essential is either outlined here or suggested without, perhaps, attaching the proper label.

Where the work is repeated in two or more grades, the material is new to each grade, or different aspects of the subject are considered.

FOURTH GRADE.

The geography of the world, beyond the environment of the fourth-grade pupils, will be approached through the children's interest in the industries which they see pursued about them, and through the products resulting from other kinds of labor not followed in this region.

During the autumn, opportunity was offered for the consideration of life in relation to the physiography of the Chicago region, through excursions to the ravine-cut lake bluff north of the city; to a farm; to the Blue Island ridge; to the clay pit at Purrington; and to a swamp. The pupils observed the means that man employs in the utilization of the forces and forms in nature for his best welfare; for instance, in the construction of piers along the lakeshore to prevent the wearing away of the land, and to induce a deposition of sand; in the use of ravines for highways to the lake; in the avoidance, for the sake of economy, of bridging ravines for railroads; in the natural and artificial drainage of swamps, and their adaptation for tillage; in the plowing of level or slightly sloping ground, leaving the steep slope to be covered by trees; in the treatment of sandy, rocky, clayey, and loamy soils for farming or gardening. All this predicated, of course, a knowledge of natural law.

During the cold months, excursions will be made to the Field Columbian Museum, the Art Institute, the conservatory in Washington Park, the zoölogical garden in Lincoln Park, and to certain manufactories. In the spring visits will be made to Dune Park for sand-dune phenomenon, and to the Desplaines river and the Chicago river.

I. ANIMALS AND THEIR HABITAT.

The interest in animals and their habits, in hunting, trapping, and fishing, is strong in the child as well as in the adult. At this season the desire for warm clothing gives an especial interest to the study of furs and fur-bearing animals. Tracing these animals to their homes may reveal the necessity for warm covering, and show their adaptation to their physical environment.

It is not expected that all the animals referred to below will be studied in detail, but one may stand as a type of a certain group in a similar environment. To illustrate: A tiger hunt with elephants in India may reveal the life, both plant and animal, of a tropic jungle. The story of the life of a seal must include its friends and foes—the bear, the walrus, fish, man, icebergs, snow, rocky islands, the long summer day, and the long winter night. A bear hunt in the Rocky Mountains will require a knowledge of the associations of the bear. In the study of fish and fishing a knowledge of rivers, lakes, and sea is demanded. It is hoped that later a fish hatchery may be established in the school, and that, by the tending of the hatchery and by trips to fish markets, a vital interest in the life-history of fish may be created.

The entire earth might be pictured in this way; for animal life of some kind is found in all parts of the world, segregated where food is abundant and the climate congenial. Animals for food, clothing, or decoration may be studied: (1) at the Stock Yards—horses, cattle, sheep, hogs, goats; (2) in Lincoln Park—wild animals, as elephant, lion, tiger; (3) in South Water street—game of all kinds; (4) at fish markets—sea products; (5) at the tannery and the fur and millinery stores—products for decoration and clothing; (6) at the Field Columbian Museum—stuffed specimens of all kinds. By the use of stereopticon and other pictures, the habits and habitat of animals may be illustrated.

(1) Note all the animals you know within your environment. (2) Form: adaptation to locomotion; to means of procuring food. (3) Color. (4) Food: range of diet, means of locating and procuring. (5) Effect of change of climate on wild animals: (*a*) migration: (α) aids to land migration—valleys, plains; (β) obstructions to land migration—mountains, deserts, large bodies of water; (γ) obstructions to water migration—temperature, deep sea; (*b*) burrowing; (*c*) hibernation, estivation. (6) Relation of domestic animals to climate; shelter, food, use. (7) Wild animals that do not migrate, hibernate, or burrow. (8) Animals used by man for food: (*a*) fish, oysters, lobsters, crabs; where abundant; manner of catching—cormorant fish in Japan, fishing by torch in Hawaii, weirs, seines, hook and line, lobster pots, oyster fishing; (*b*) game: hunting, trapping; game most highly prized in our markets; how obtained; (*c*) domestic animals—cattle, sheep, hogs, poultry. (9) Animals used for clothing: (*a*) skins for leather—cattle, sheep, goat, alligator, kangaroo, deer; how prepared; (*b*) for fur—seal, beaver, sable, otter, ermine; (*c*) for hair—goat, yak, llama, camel, tiger; (*d*) feather—ducks, geese, ostriches, eagles, in fact almost all birds; how obtained. (10) Animals used as beasts of burden: horse, mule, cow, buffalo, elephant, camel, dog, llama, reindeer. (11) Animals not used by man for food, clothing, burden, bearing: home, habit, use. (12) Relation of animals to soil: (*a*) burrowing—earthworm, mole, crayfish; (*b*) musk-rat, beaver, hog; (*c*) birds. (13) Relation of animals to vegetation: forests, prairies, deserts, and semi-deserts. (14) Æsthetic value of animals: (*a*) why wild animals play so small a part in our landscape; (*b*) their abundance in Burmah and India. (15) Ethical aspect of man's relation to animals: (*a*) destruction of birds for use in millinery; (*b*) hunting for sport; (*c*) treatment of beasts of burden; of animals

used for clothing, for food; the necessity of societies for prevention of cruelty to animals.

Model in clay, paint, and draw certain animals seen at Lincoln Park and elsewhere. Represent animals in native habitat.

REFERENCES: Seton Thompson, *Some Wild Animals I Have Known;* Kipling, *Jungle Books;* Thomsen, *Study of Animal Life;* Jordan, *Animal Life;* Lubbock, *Beauties of Nature;* Mill, *Realm of Nature;* J. G. Woods, *Common Objects of the Country;* Wallace, *Distribution of Animals* and *Island Life;* Heilprin, *Distribution of Animals;* Drummond, *Tropical Africa;* Bates, *Naturalist on the Amazon;* Kingsley, *Water Babies;* John Burrough, *Squirrels and Other Fur Bearers; Wake Robin; Winter Sunshine; Fresh Fields; Birds and Poets;* Wood, *Natural History;* S. W. Baker, *Wild Beasts and Their Ways; Reminiscences of Europe, Asia, Africa, and America.*

II. METALS AND MINING.

The work that the pupils are doing in metals leads them to the mines as the source of supply of metals.

Visit a foundry, the economic geology department, Field Columbian Museum. Description of placer mining in Alaska; of a quartz mine. Account for concentration of metal which makes mining possible.

CRYSTALLIZATION.

All of the minerals and metals of the earth tend to crystallize.

Visit Field Columbia Museum.

Solution and crystallization: (1) Observation of crystals: (*a*) at home—sugar, salt, soda, etc.; (*b*) out-of-doors—snow, ice; (*c*) in drug stores—alum, blue vitriol, bichromate of potash, copperas, etc.; (*d*) in museum—quartz, calcite, copper, fourite, galena, etc. Note differences in form, color, size of crystals of same mineral; of different minerals. (2) Solution (try to dissolve different solids, as sugar, salt, alum, rocks): (*a*) in cold water; (*b*) in cold water plus acid; (*c*) in hot water; (*d*) in hot water plus acid; (*e*) in a saturated solution, as of sugar; try to dissolve salt, blue vitriol, etc. (3) Crystallization: (*a*) from saturated solution of salt, sugar, alum, blue vitriol, copperas, saltpeter, and bichromate of potash, allow crystals to form; (*b*) make mixed solution of blue vitriol, alum, etc., and allow to crystallize; (*c*) put coloring matter into a saturated solution, and note effect on crystals; (*d*) allow different solutions of salt, alum, copperas, etc., to evaporate, and note result; (*e*) mold and paint crystals of different forms and colors.

REFERENCES: "The Donkey and the Salt," *Æsop's Fables,* stories; F. D. Shenna, "Wizard Frost," poem; Dana, *Crystallography;* Dana, *Minerals and How to Study Them;* Tarr, *Elementary Geology;* Scott, *Introduction to Geology;* Ruskin, *Ethics of the Dust;* Geikie, *Text-Book of Geology;* Shaler, "Minerals and Mining," *United States of America,* p. 485.

III. TRANSPORTATION.

The children's interest in boats, trains, and means of obtaining foreign products will lead to the study of transportation. Visit shipyard, Pullman car works, Field Columbian Museum, for modes of transportation, present and historical; Chicago river—a commercial highway.

I. Transportation by water: (1) seas and lakes—harbors, docks, lighthouses, freight and passenger boats; (2) rivers—boats seen on Chicago river; (3) canals, with locks and without locks.

II. Transportation by railroad: cars—freight, box, flat, refrigerator; Pullman and passenger coaches.

III. Telegraphs, cables, telephones, in connection with transportation; laying of cables.

IV. Beasts of burden: (1) horse, mule, cow, llama, buffalo, elephant, camel, donkey, dog, reindeer, man; (2) how used? in what countries? why used?

V. Vehicles drawn by animals: wagons, sleds, carriages.

REFERENCES: T. M. Cooley, *Transportation;* Shaler, *United States of America;* "Transportation Question," *Scribner's*, Vol. XVI, p. 687; "History of Canals," *Knight's American Dictionary*, Vol. I, p. 436; J. A. Satcha, "Cheap Transportation in the United States," *North American Review*, January-June, 1897; "Ship Canals," *Living Age*, Vol. CLXXXIV, p. 516; Adams, "Transportation," *Commercial Geography*, p. 39; "Transportation by Railway and Ship Canal," *Harper's*, Vol. LX, p. 577; L. M. Shaler, "Beasts of Burden," *Scribner's*, July-December, 1894, p. 82; "Roads, Streets, and Vehicles," *Iconographic Dictionary*, p. 149; "Canals," *ibid.*, p. 312; H. G. Prout, "Railroads," *United States of America;* "History of Railroads," *Iconographic Dictionary*, p. 170; "Telegraphs and Telephones," *ibid.*, p. 344; Shaler, *Land and Sea; Formation and Preservation of Harbors*, pp. 187, 223.

IV. FORESTS.

Through the work in wood in the sloyd shop, visits to car factory and furniture manufactories, interest in the source of wood supply will lead to a study of forests. Visit Washington Park conservatory for tropical vegetation.

I. Kinds of trees in this region seen in parks and on trips to country: (1) changes in appearance due to season; loss of leaves or bark; (2) varieties used for lumber; the properties that give commercial value.

II. Use of forests: (1) to animals—shelter, food, protection; (2) to soil—fallen leaves enrich soil; roots hold soil in place; roots and leaves retain moisture.

III. Forests on plains and on mountains: (1) kinds of forests: (*a*) tropical—summer and winter appearance; varieties of wood we use from tropic; (*b*) temperate—seasonal appearance; varieties in this region; use; (*c*) frigid—seasonal appearance; varieties; woods we use. (2) Deforestation: by fire, by man, by grazing of animals; effect upon (*a*) soil; (*b*) rivers; (*c*) vegetation; (*d*) civilization. (3) Planting of forests: (*a*) location; (*b*) method; (*c*) kind of trees. (4) Care of forests.

REFERENCES: Marsh, "The Woods," *Man and Nature*, pp. 57 and 128; *Encyclopedia Britannica* (see index); Andrews, *Louise, the Child of the Western Forest*, 1861, pp. 121–37; Eggleston, "The Value of Our Trees," *Popular Science*

Monthly, 1881, Vol. XIX; Lubbock, *Beauties of Nature*, p. 179; Marsh, *The Earth* (see index under "Wood"); Mill, *The Realm of Nature;* Oswald, "The Climatic Influence by Vegetation," *Popular Science Monthly*, 1872, Vol. I, pp. 385-90; Shaler, *Aspects of the Earth*, 1890, pp. 257-99; Shaler, *Story of Our Continent*, 1892 (see index under "Forest"); Stanley, *In Darkest Africa*, 1878 (see index under "Wood"); Smith, *Brazil*, 1879, pp. 176-204; Somers, "Forests of the California Coast Range," *Harper's*, Vol. LXXIX, pp. 652-60.

V. FARMING.

Visit a farm where plowing, planting, and other farm activities can be seen.

I. Products the farm gives to the city (visit grocery store and Stock Yards): (1) vegetables—radishes, cabbages, onions, potatoes, lettuce, etc.; (2) grains—wheat, oats, corn, rye, buckwheat; (3) animals—cattle, horses, sheep, goats, poultry, eggs, butter; (4) fruit—apples, peaches, pears, grapes, plums, berries; (5) food products from tropical farms—oranges, lemons, dates, etc.; (6) cultivation of products—use of plowing, harrowing, weeding, fertilizing; (*a*) machinery used in farming; (*b*) implements used by primitive people in cultivating the soil; (*c*) animals used in farm work; how tended; (*d*) animals used by Asiatic farmers which we do not use, as camel, water-buffalo.

II. The school garden.

The pupils will aid, as far as possible, in the preparation and planting of the school garden. (1) Plant common vegetables; grains, as wheat, corn, oats, rye, barley, rice, cotton, flax, tobacco, sugar-cane.[1] (2) Difference between cultivated and uncultivated areas. (3) Allow weeds to grow in a small part of the garden, and note the effect upon the vegetables. Let the soil remain hard around some plants and loose around others; note result. (4) Soil: loamy, sandy, or clayey. Plant same kind of seed in each kind of soil, irrigating equally; note result. (5) Relation of rainfall to amount of moisture needed by the garden. How to irrigate the garden. Pupils will work out different plans for irrigation, on flat, slightly sloping, and steep sloping ground, by flooding; by basins or checks; by furrows and ditches, in place of checks; by furrows run in parallel systems. (*a*) Source of water supply, here; source of water supply in regions where irrigation is imperative; wells, rivers, catch-basins; (*b*) value of irrigation to vegetation: temperature, material deposited, material dissolved. Stories of Egyptian irrigation by the aid of shâdûf, or kind of sweep, in lifting water from the Nile; by the saqiya, or waterwheel. (6) Relations of animals to garden plants: (*a*) those which do not injure the plants; (*b*) those which do injure the plants; (*c*) how prevent unfriendly visitors. (7) When should the garden be harvested? (*a*) plants used while immature; (*b*) plants allowed to mature.[2]

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[1] Although cotton and sugar-cane may not mature before frost, the pupils will gain a knowledge of the growing plant. By use of pictures and descriptions the mature crop and the mode of harvesting may be shown.

[2] Pupils will prepare for lunch such vegetables as are ready for use before school closes.

III. Customs and superstitions in regard to certain products, as rice, wheat, and corn: rice, for instance, has been planted yearly by the emperors of China since 2500 B. C.; it is used in sacrifice to appease deity during eclipse, and in exchange of compliments in oriental diplomatic circles.

REFERENCES: Gaye, *World's Great Farm;* Illinois Department of Agriculture, *Transactions*, Vols. XII, XVI, XX, XXIV, XXVII; *Illinois Farmers' Institutes*, Vols. I, II, III; Ratzel, "Agriculture and Cattle Breeding," *History of Mankind* (1896), Vol. I, pp. 87–93; Storer, *Agriculture in Some of its Relations with Chemistry;* "Growth of Industrial Arts," United States, *House Miscellaneous Documents* (1892), Vol. XXX; King, *Soil;* Merril, *Rocks, Rock Weathering, and Soil.*

References on irrigation: *Year-Book of the Department of Agriculture*, 1895, p. 482; King, "Irrigation," *The Soil*, pp. 75, 268; Marsh, "Irrigation," *The Earth*, pp. 67, 448; Liebig, "Effect of Irrigation on Injurious Organic Matter," *Modern Agriculture;* Murray, "Irrigation in Egypt," *Handbook, Egypt*, p. 47; "Drainage and Irrigation," *Iconographic Dictionary*, pp. 32, 323.

APPLIED MATHEMATICS.

GEORGE W. MYERS.

THE TEACHING OF ARITHMETIC.

MANY schoolmasters seem quite certain that most of the troubles which afflict school work have their root in arithmetic. The basis of their certainty is not sufficiently clear, however, to carry conviction to the minds of those hard-headed, practical men whose contact with affairs leads them to look upon school work as a serious matter for those pupils who have their place in life to make and to hold. To such persons education means much more than the devising of a system for exemplifying, or even *verifying*, pedagogical tenets. Fortunately for all of us, there is always one or more of such "troublesome fellows" in an important official relation to the school system of nearly every community.

If it were not for this fact, it can scarcely be doubted that the mathematical subjects would have fallen out of the curricula long ago. These subjects are rarely upon the program of instruction because the superintendent or the teacher would have them there. It is so much more agreeable, generally, to have to do with subjects which deal with opinions, or with more or less plausible vagaries and generalities, where there are no easy